

Lagrangean Coherent Structures (LCSs)

M. J. Olascoaga and L. Fiorentino

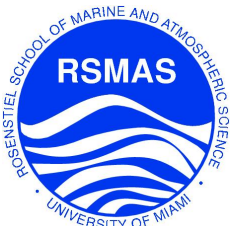
Division of Applied Marine Physics

Rosenstiel School of Marine and Atmospheric Science

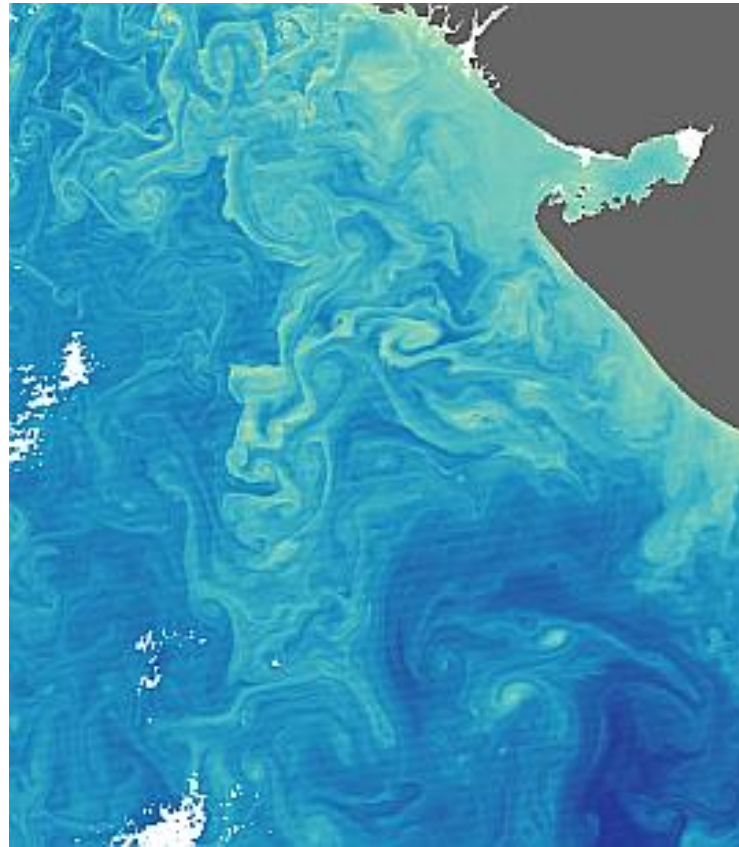
University of Miami

Miami, 14 March 2011.

jolascoaga@rsmas.miami.edu
www.rsmas.miami.edu/personal/jolascoaga



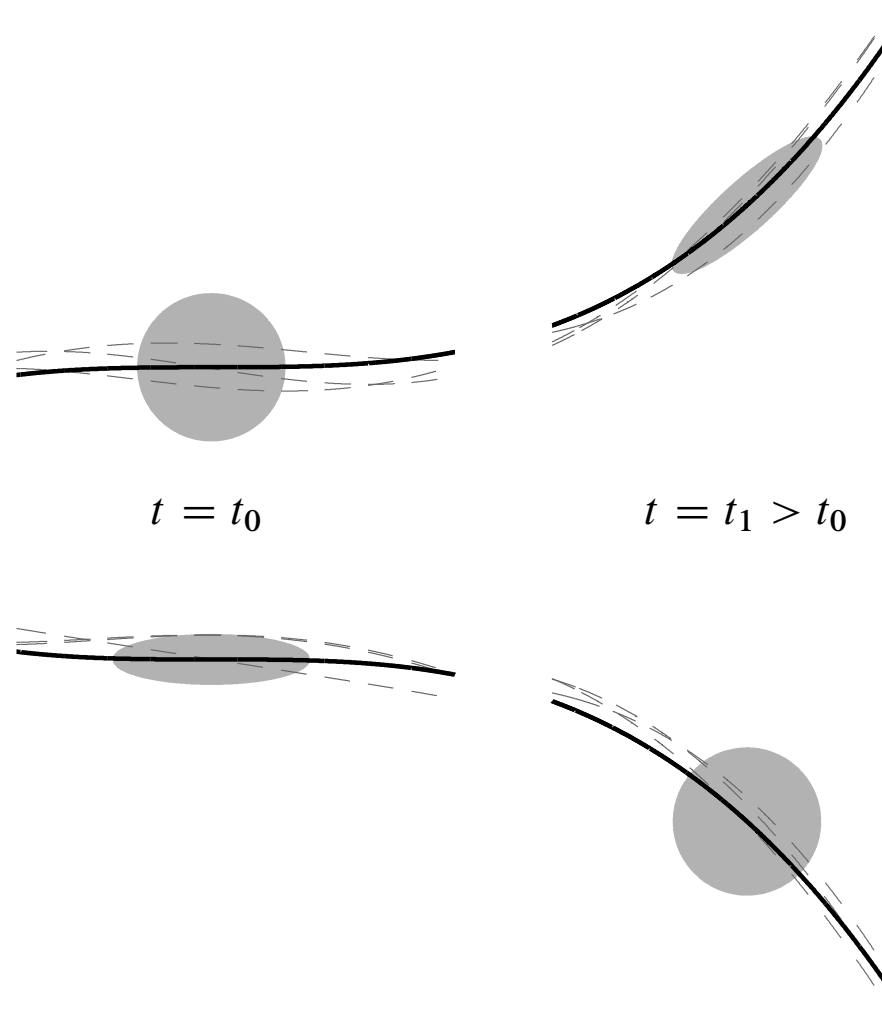
Motivation



Passive tracers (e.g., pollutants, plankton, etc.) tend to develop intricate patterns as a result of the advection by unsteady ocean currents. Great insight into the formation of these patterns can be achieved by identifying the skeletons around which they organize. Such skeletons are composed of distinguished material fluid surfaces known as Lagrangian Coherent Structures (LCSs).

What are LCSs?

Haller 2011 (Physica D 240, 574-598).



LCSs are locally the strongest normally attracting or repelling material fluid surfaces. One consequence is that attracting (repelling) LCSs contain information on the future (past) history paths of fluid particles.

How do we identify LCSs?

- The LCSs are not apparent to the naked eye inspection of velocity field snapshots.
- One tool that is capable of revealing LCSs is given by the Finite-Time Lyapunov Exponent (FTLE).
- The FTLE is a separation rate measure of initially nearby fluid particles.
- LCSs tend to produce locally maximizing curves or ridges in the FTLE field.
- The LCSs can be computed based on a given velocity realization (e.g., model derived, inferred using HF radar technology, etc.).

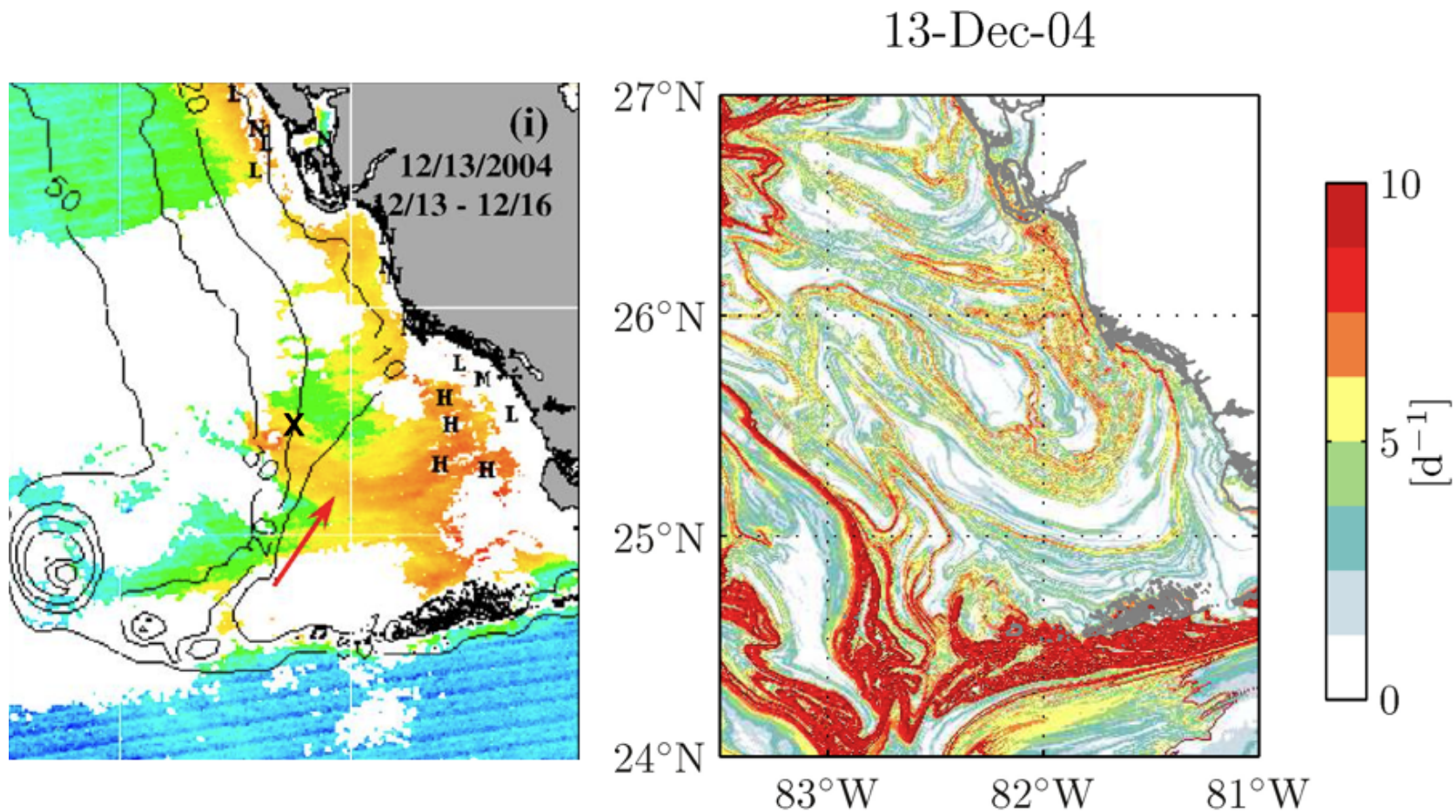
Example 1: Hobbie Beach

Fiorentino et al. 2011 (in preparation).

Note the tendency of the synthetic drifters to follow the attracting LCSs. For more details see the poster Fiorentino et al. March 16 6-8pm.

Example 2: West Florida Shelf's red tides

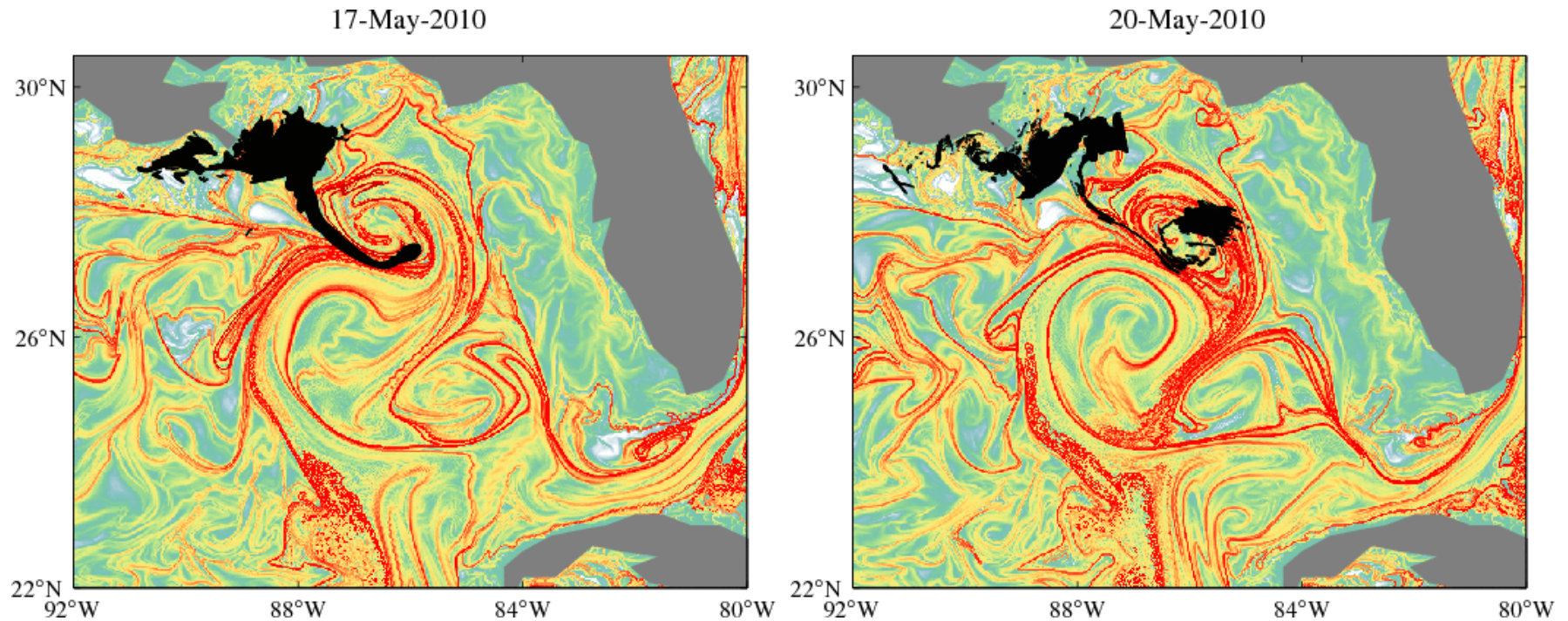
Olascoaga et al. 2008 (J. Geophys. Res., 113: C12014).



Note the similarity of the red tide distribution and the LCS patterns.

Example 3: Oil spill in the Gulf of Mexico

Olascoaga 2010 (Nonlin. Processes Geophys., 17, 685-696).



Note the tendency of the spilled oil to follow the attracting LCSs.